

CLAIMS

1 A method for coating a substrate with an
inorganic-organic hybrid polymer material using the
5 Dielectric Barrier Discharge (DBD) technique, said method
comprising the steps of:

- a) introducing a sample in the space between two
electrodes,
- b) controlling the atmosphere between the
10 electrodes,
- c) generating a plasma discharge between the
electrodes,
- d) mixing aerosols containing hybrid
organic/inorganic cross-linked pre-polymers formed via sol-
15 gel processing, into the plasma discharge.

2. A method as claimed in claim 1, wherein one
or more of the following additional components may be added
to the plasma discharge: gases, vapors, aerosols or powders
20 of non cross-linked precursor chemicals.

3 A method as claimed in claim 1, wherein the
aerosol in step d) comprises a compositional gradient of
the pre-polymers and/or any additional admixed components.
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4 A method as claimed in claim 1, wherein the
plasma is maintained at a pressure from about 100Pa to
about 1MPa.

30 5. A method as claimed in claim 1, wherein the
plasma is generated by alternating voltage between the
electrodes of a frequency from about 10Hz to about 50MHz.

6 A method as claimed in claim 1, wherein the
substrate comprises plastic, non-woven or woven fibers,
natural, synthetic or semi-synthetic fibers, cellulosic
material, metal, ceramic, powder or any composite structure
5 thereof.

7 A method as claimed in claim 1, wherein the
hybrid inorganic-organic coating increases, decreases
and/or controls one or more of the following physical
10 properties compared to the uncoated substrate: hydrophilic,
hydrophobic, oleophilic, oleophobic, adhesive, release, gas
diffusion barrier, liquid diffusion barrier, solids
diffusion barrier, chemical resistance, UV resistance,
thermal resistance, flame retardancy, porosity,
15 conductivity, optical, self cleaning, acoustic, roughness,
wear resistance, scratch resistance, lubricating,
antimicrobial, biocompatible, sensory, catalytic
properties, humidity, drug release, softness to touch,
taste, smell, insect repelling properties, allergic
20 reaction, toxicity, acid-base level.

8 A method as claimed in claim 1, wherein the
coating is an inorganic-organic hybrid polymer obtained
and/or obtainable from an aerosol containing cross-linked
25 inorganic-organic hybrid pre-polymer, formed via sol-gel
processing.

9. A method as claimed in claim 1, wherein the
inorganic-organic hybrid pre-polymer is obtained and/or
30 obtainable from one or more of: Tetramethoxysilane;
Tetraethoxysilane; Dynasil 40; Zirconium-tetrapropoxide;
Aluminium-tributoxide Titanium-tetraethoxide; Aluminium-
dibutoxide ethylacetoacetate; Zirkonium-tripropoxide

methylacrylate; Bayresit VPLS 2331 ;
 Propyltrimethoxysilane; ; Phenyltrimethoxysilane;
 Diphenyldimethoxysilane; Mercaptopropyltrimethoxy-silane;
 Tridecafluoro-triethoxysilane; Aminopropyltriethoxy-silane;
 5 Trimethylammonium-propyltrimethoxysilane;
 Octadecyldimethylammonium-propyltrimethoxysilane;
 Vinylbenzyl ammoniummethyl aminopropyltrimethoxysilane;
 Succinic acid anhydride propyl triethoxysilane;
 Glycidoxypropyl-trimethoxysilane; Vinyltrimethoxy-silane;
 10 Methacryloxypropyl-trimethoxysilane; TPGDA-silane; TEGDA-
 silane; BPADA-silane; LR 8765 silane; GDMA-silane and/or;
 PETA-silane, silylated polymers and/or suitable mixtures
 thereof.

15 10 A method as claimed in claim 1, where the
 pre-polymer mixture in step d) further comprises -
 inorganic coating forming materials preferably selected
 from : colloidal metals, metal oxides, organometallic
 compounds and/or
 20 - organic coating forming materials; preferably selected
 from : carboxylates, (meth)acrylates, styrenes,
 methacrylonitriles, alkenes and/or dienes, (meth)acrylic
 acid, fumaric acid (and esters), itaconic acid (and
 esters), maleic anhydride, halogenated alkenes,
 25 (metha)acrylonitrile, ethylene, propylene, allyl amine,
 vinylidene halides, butadienes, (meth)acrylamide, epoxy
 compounds, styrene oxide, butadiene monoxide,
 ethyleneglycol diglycidylether, glycidyl methacrylate,
 bisphenol A diglycidylether (and its oligomers),
 30 vinylcyclohexene oxide and phosphorus-containing compounds
 and/or any suitable mixtures thereof.

11. A method as claimed in claim 1, wherein the inorganic-organic hybrid coating is obtained and/or obtainable by mixing separately in addition to the aerosol in step d) one or more additional gases, vapours, aerosols
5 or powders of the following compounds to the plasma discharge: Ar, He, O₂, N₂, CO₂, CO, SF₆, NO, NO₂, N₂O, H₂, methane, ethane, propane, butane, ethylene, propylene, ethylene oxide, propylene oxide, acetylene, CF₄, C₂F₆, C₂F₄, H₂O and/or any of the ingredients described in claim 10.
- 10 12. A method as claimed in claim 1, wherein the coating is applied as a liquid precursor.
13. A method as claimed in claim 1, wherein the
15 substrate which is coated is selected from: a powder, wire and a moving material web.
14. A coated substrate obtained and/or obtainable by a method as claimed in claim 1.
- 20 15. An apparatus for generating and maintaining a plasma for use in a method as claimed in claim 1; the apparatus comprising a pair of electrodes, a gap being present between said electrodes, and a voltage generator
25 for applying a voltage between said electrodes, said electrodes comprising an electrically conducting material, wherein one or both electrodes are covered with an electrically insulating material, and wherein the generator is capable of generating an alternating voltage a
30 frequency from about 10Hz to about 50 MHz.

16. The apparatus according to claim 15, wherein said electrodes have the form of planar or curved plates or grids, bars, cylinders, or knife or brush type geometries.

5 17. The apparatus according to claim 15, wherein one or both of said electrodes is segmented in different parts of any shape.

18. The apparatus according to claim 15,
10 comprising a parallel and/or serial combination of one or more of said electrodes.

19. The apparatus according to claim 15, wherein one or both electrodes are temperature controlled.

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20. The apparatus according to claim 15, wherein one or both of the electrodes is movable.